
Environmentally Friendly Coating Systems for Department of Defense Applications

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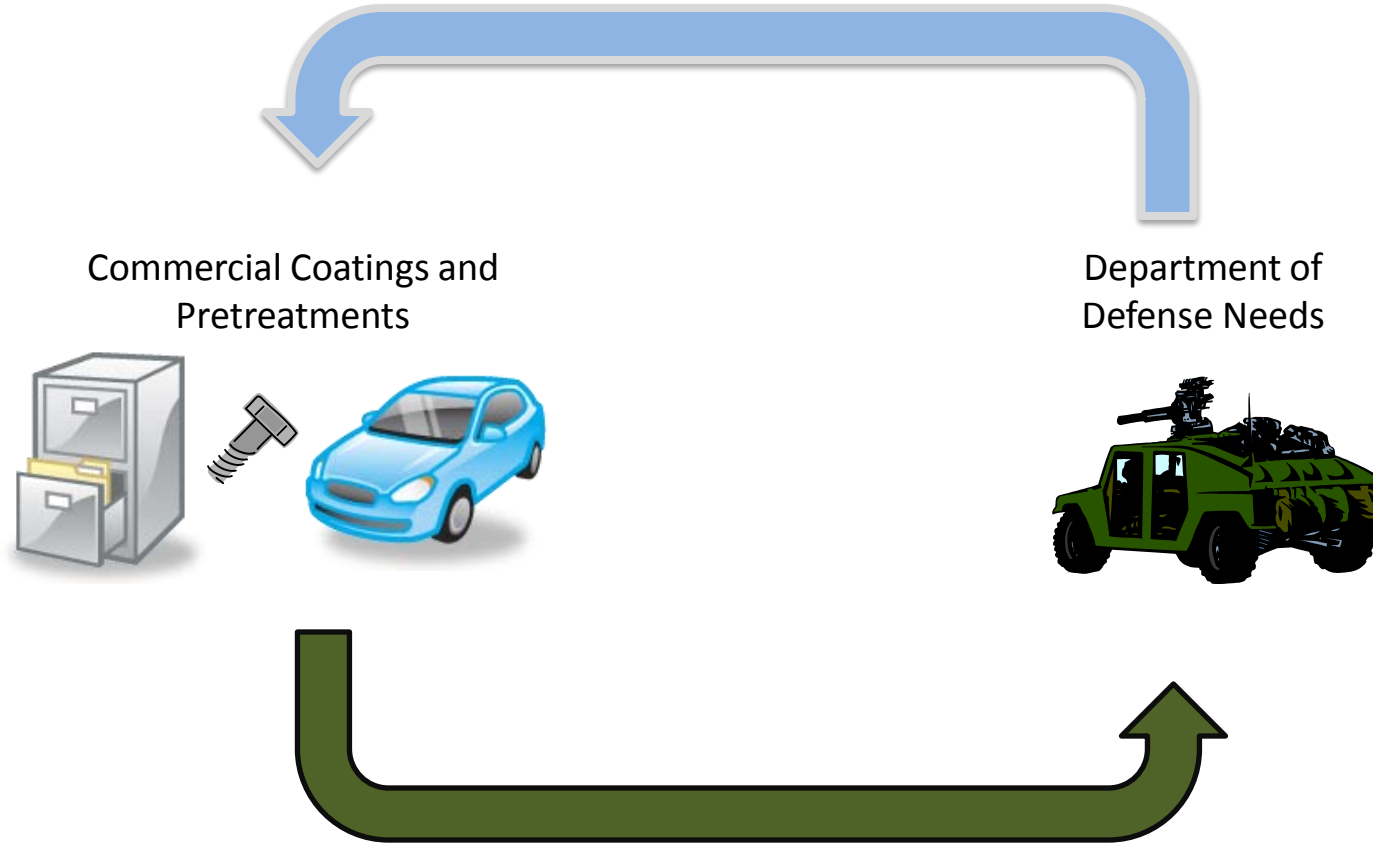
U.S. Army Corrosion Summit
Huntsville, Alabama
February 9-11, 2010



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Evaluation of New Technologies



Programs

E-Coat for Munitions Modernization



<http://www.theodoregray.com/PeriodicTable/>

Environmentally Friendly Zirconium Oxide Pretreatment



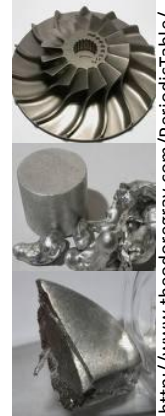
SERDP WP-1676

E-Coat for Munitions Modernization



ARDEC Personnel

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Dan Schmidt
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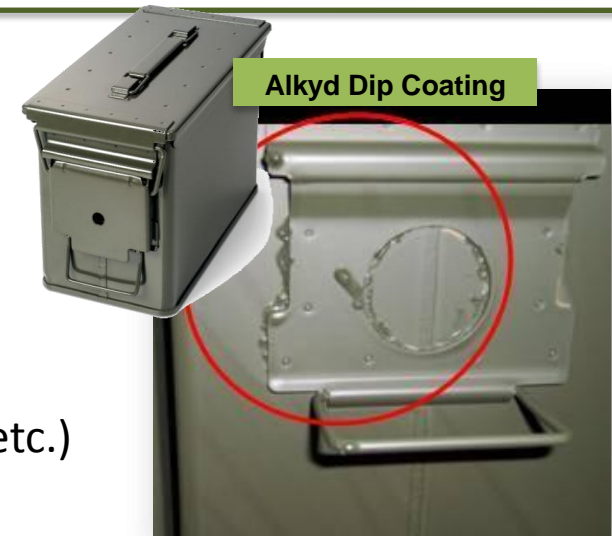
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- “Electrocoat for Munitions Modernization”
 - Jules Senske, U.S. ARMY Corrosion Summit, 13 February 2008
- Coatings for munitions modernization
 - Project originally targeted acrylic electrocoat development
 - Expanded to powder coatings and other environmentally friendly treatments for munitions applications

Coatings for Munitions Modernization

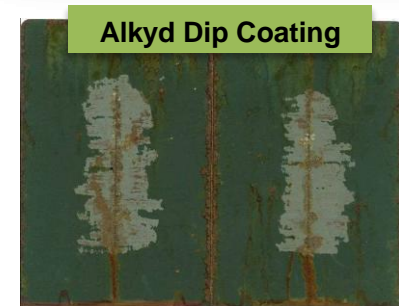
- Current commercial munitions coatings

- Alkyd Enamels (Mil-E-52891, Mil-DTL-11195)
- Applied by spray or dip process
- Salt-spray resistance requirement, 150 hrs
- Possible aesthetic drawbacks (runs, drips, sags, etc.)

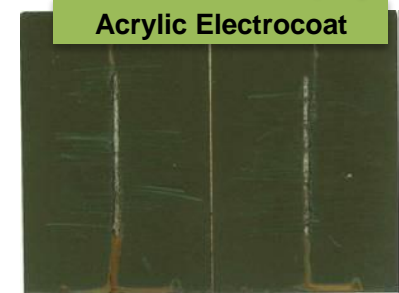


- Coatings for munitions modernization

- Acrylic electrocoat and polyurethane powder
- Higher work efficiency/simplified process
- Durability > 750 WOM
- Salt-spray resistance > 400 hrs
- High transfer efficiency (approach 95-100%)
- Low or no VOC
- Widely used industrially



500 hrs neutral salt spray

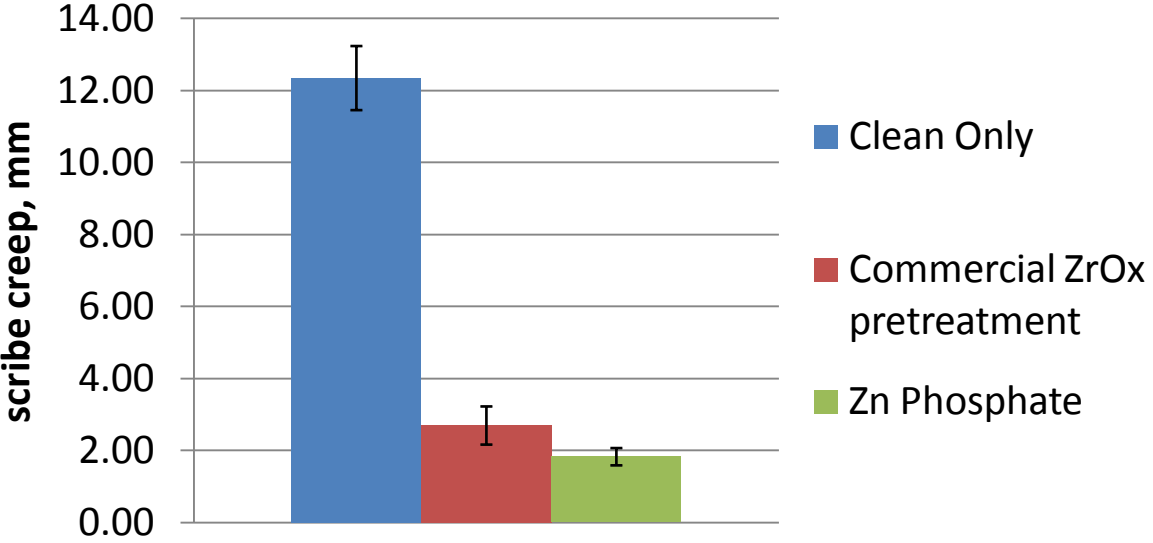


Coatings for Munitions Modernization (Systems Approach)

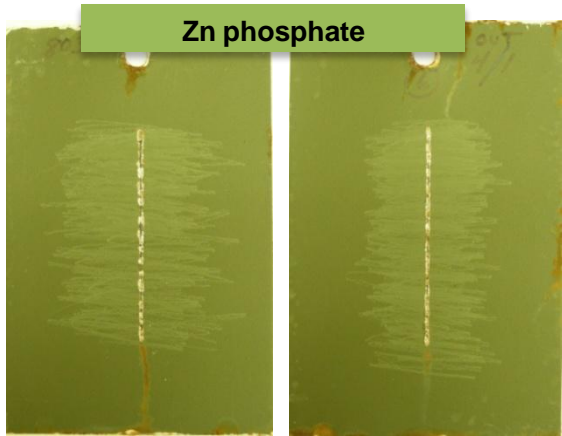
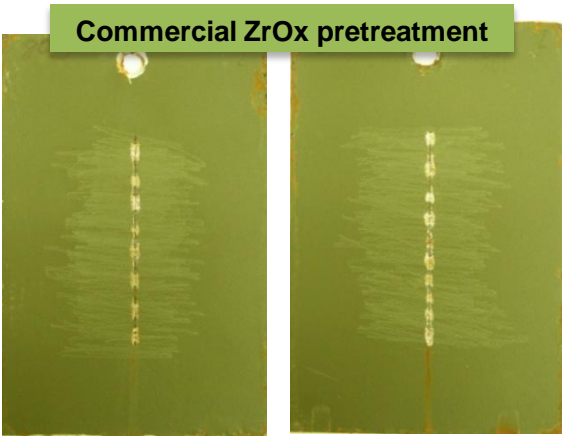
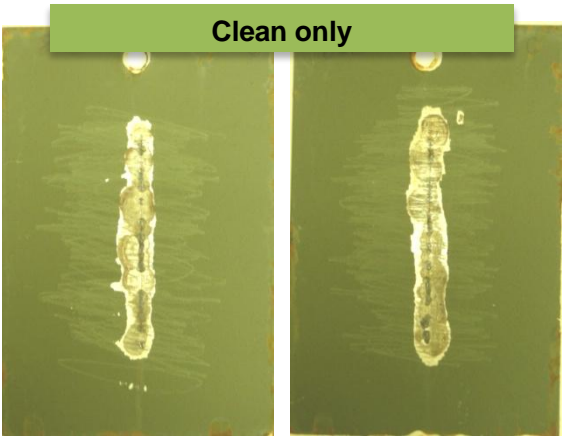
- Development of complementary coating systems for munitions applications
 - Opportunity to evaluate E-Coat and powder on munitions substrates
 - Systems approach for asset protection and enhancement
 - Aluminum, magnesium, and titanium
 - Stainless steel and high-strength steel (armor applications)

Systems Approach (Commercial Pretreatments with Powder Coating)

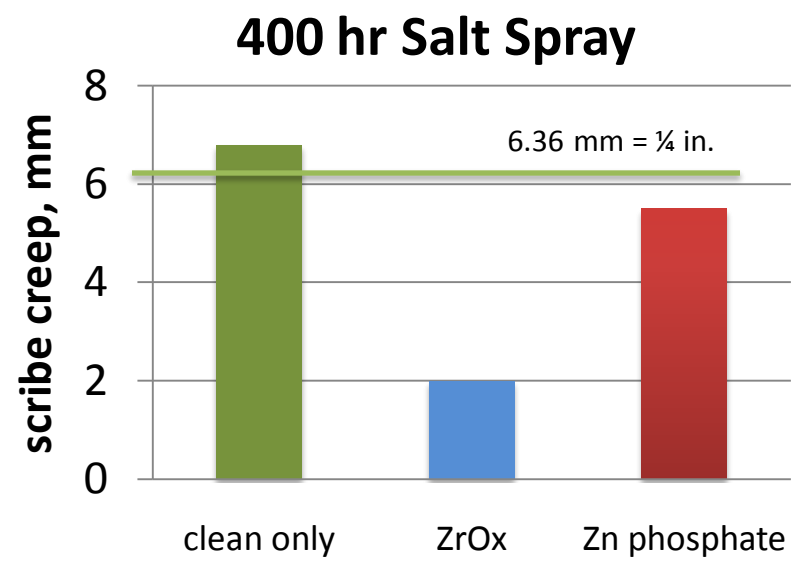
GM9540P, 20 cycles



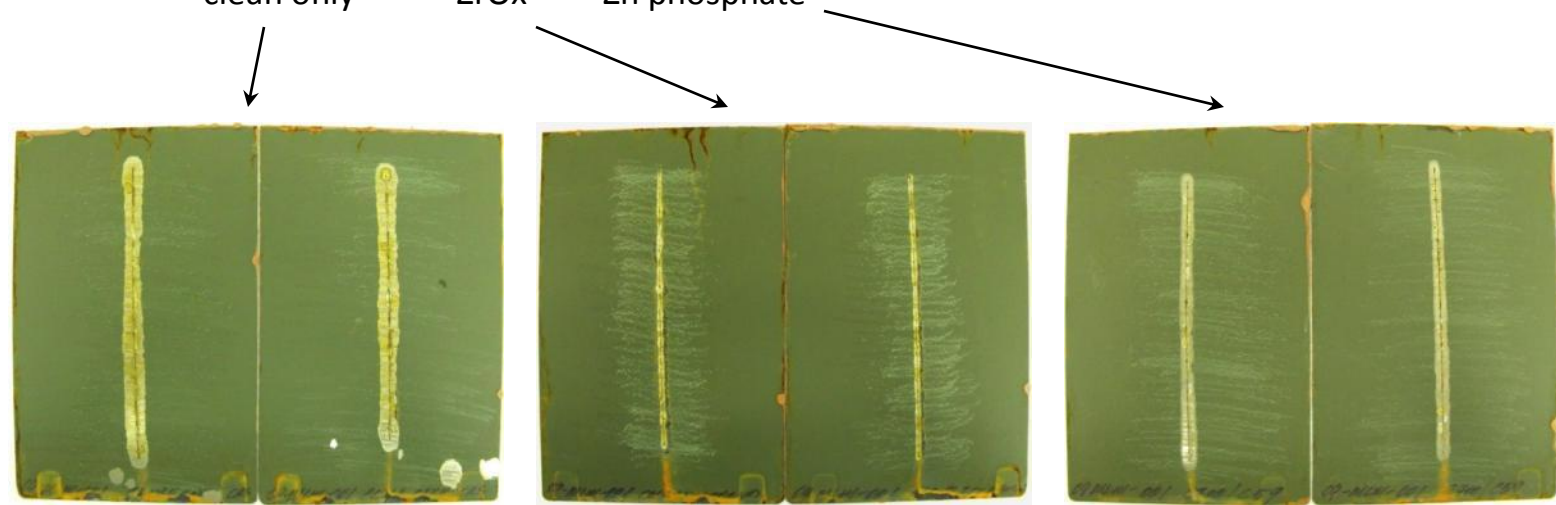
- Cold-rolled steel
- 2 mil Polyurethane powder coating
- Pretreated samples had < 1/4" scribe creep after 20 cycles GM9540P



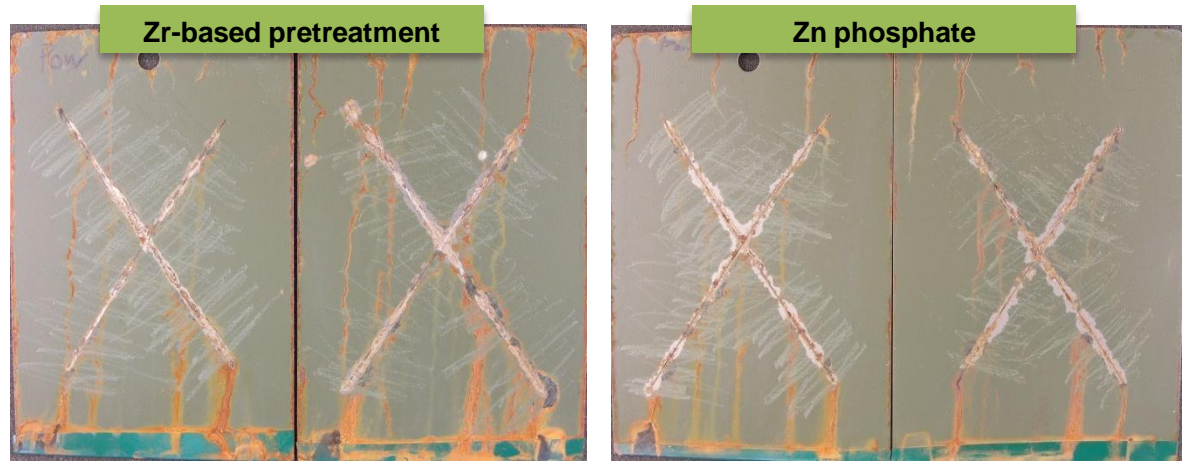
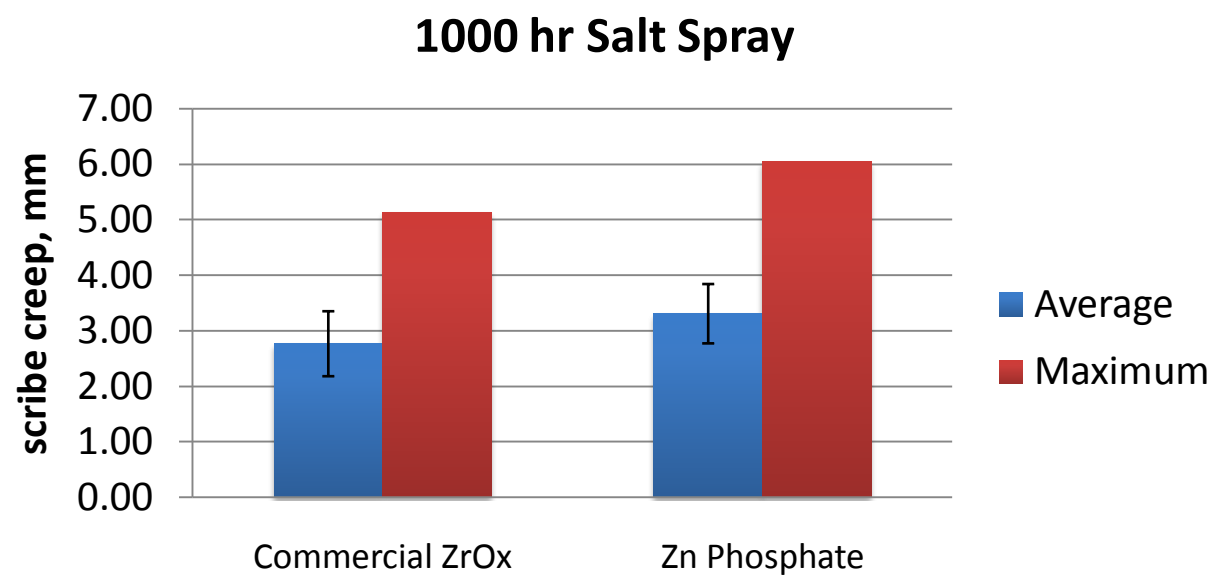
Systems Approach (Commercial Pretreatments with Powder Coating)



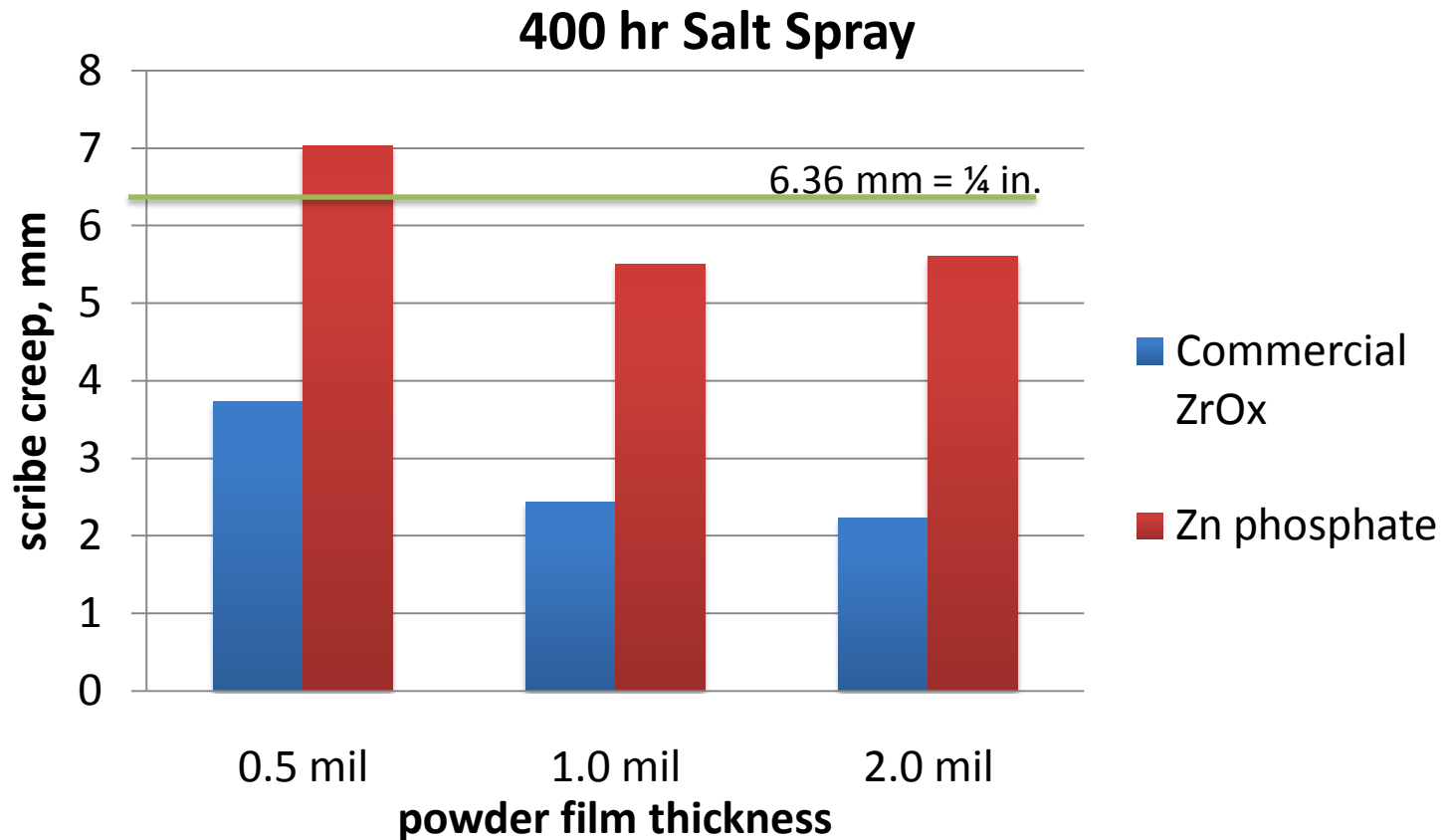
- Cold-rolled steel
- 2 mil Polyurethane powder coating
- Pretreated samples had < 1/4" scribe creep after 400 Salt-Spray



Systems Approach (Commercial Pretreatments with Powder Coating)

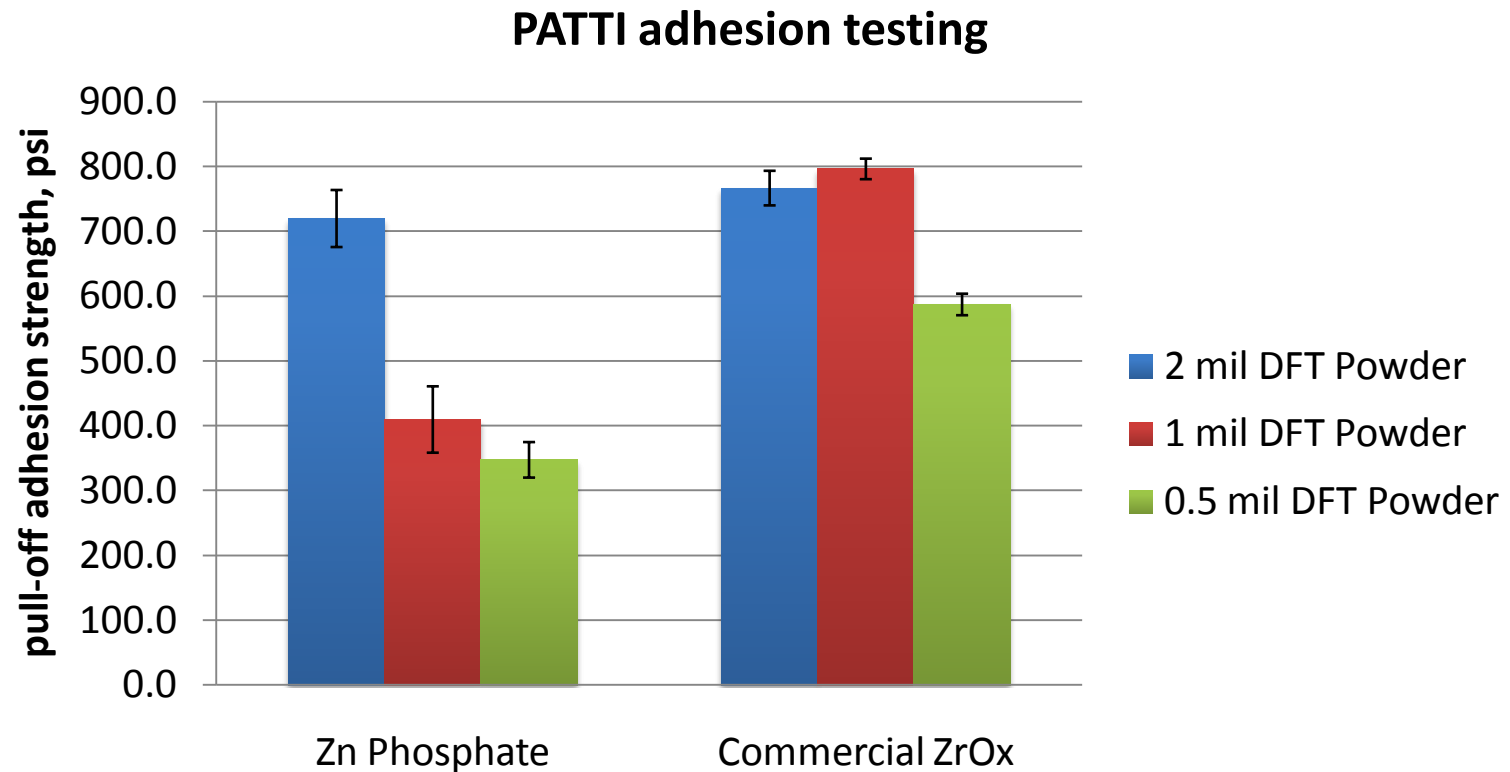


Systems Approach (Commercial Pretreatments with Powder Coating)



- 2 mil film build specification for polyurethane powder coatings
- ZrOx outperforms commercial Zn Phosphate
- Scribe creep specification met at all film thicknesses for ZrOx

Systems Approach (Commercial Pretreatments with Powder Coating)



- 2 mil film build specification for polyurethane powder coatings
- Better adhesion at all coating thicknesses for the ZrOx pretreatment

Systems Approach (Commercial Pretreatments with Powder Coating)

- Conclusions
 - Polyurethane powder/commercial pretreatment coating systems perform well in the testing outlined in Mil-E-52891 and Mil-DTL-11195, with several added environmental benefits over alkyd systems.
 - The powder/commercial zirconium pretreatment system provides performance superior to Zn phosphate, in adhesion and corrosion testing (ASTM B117 and GM9540P), at lower applied powder thickness.
- Path forward
 - Pretreatment systems for Ti, Mg, and Al alloys
 - Study the electrocoat system with commercial ZrOx pretreatments

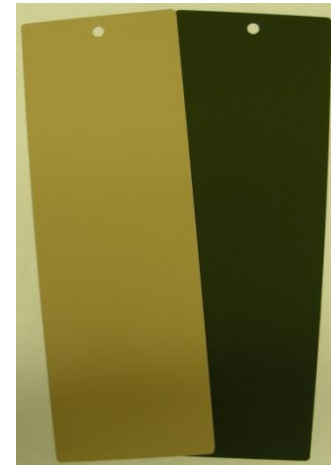
Environmentally Friendly Zirconium Oxide Pretreatment



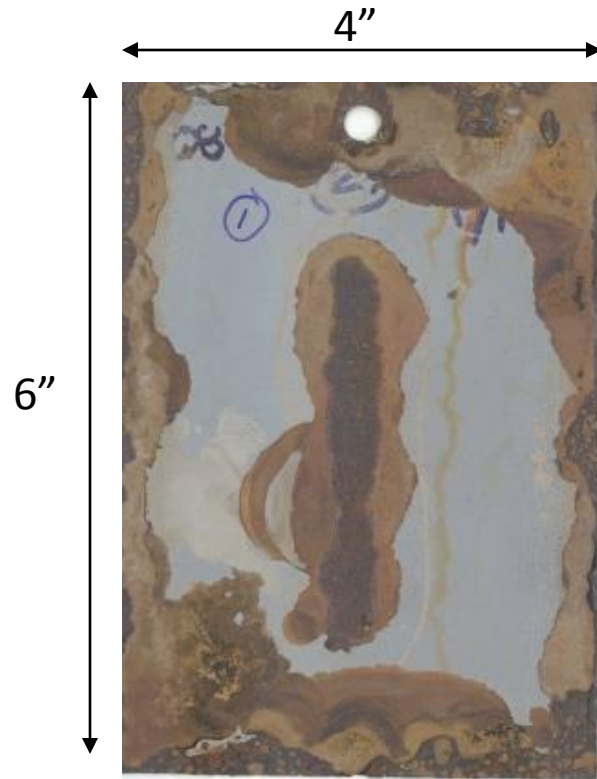
SERDP WP-1676



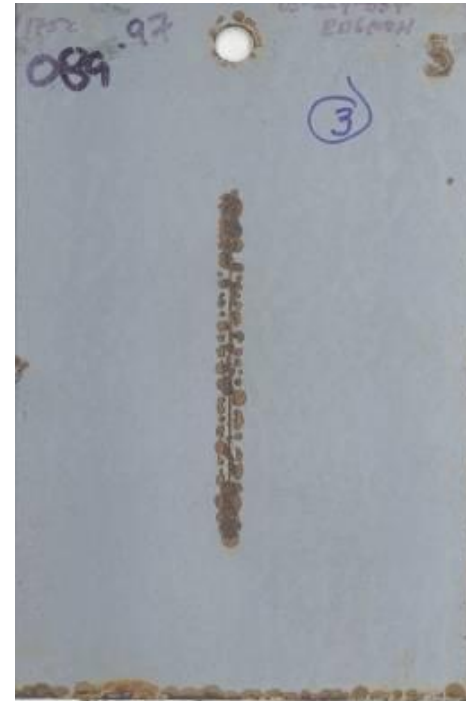
ARL Personnel
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Fred Lafferman
Daniel Pope
Pauline Smith



Do We Need Pretreatment?



No pretreatment



Zinc phosphate pretreatment

Electrocoated steel panels after GM 9540 cyclic corrosion testing

Environmentally Friendly Zirconium Oxide Pretreatment

Environmental/Health Impact

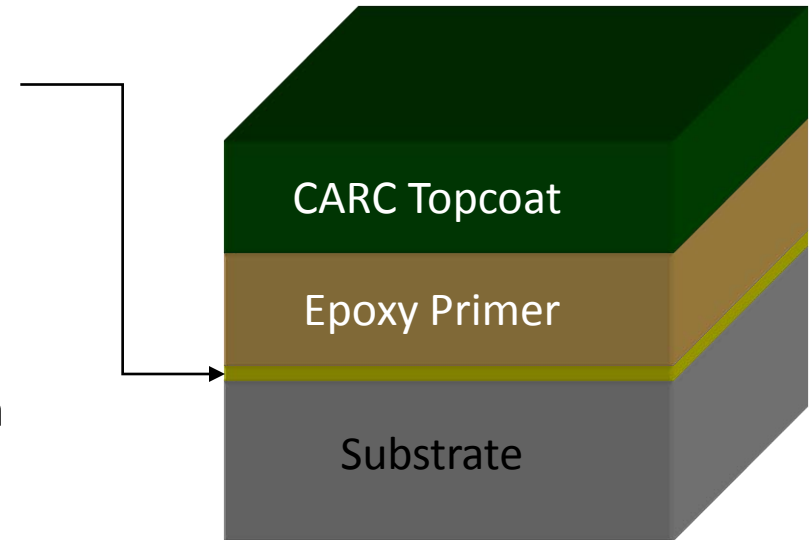
- DoD Wash Primer systems
 - 7.1% zinc chromate
 - 6.5 lb/gal of VOCs
- Yearly est. usage of 21,000 gal
 - 12,600 lb of zinc chromate
 - 35,700 gal of package/thinner solvents
- Environmental concerns and EPA regulatory issues associated with solvent emissions
- Worker safety and OSHA compliance issues related to the presence of regulated metals



Environmentally Friendly Zirconium Oxide Pretreatment

Wash Primer/Pretreatment

- Chemical Agent Resistant Coating (CARC) specification, MIL-C-53072, requires metal surfaces be treated to improve coating adhesion and corrosion resistance
- Zinc phosphate pretreatment required for Original Equipment Manufacturers
- Hexavalent Chrome (Cr^{6+}) containing wash primer required for Depot and Repair operations



SERDP 1676 Project Objective

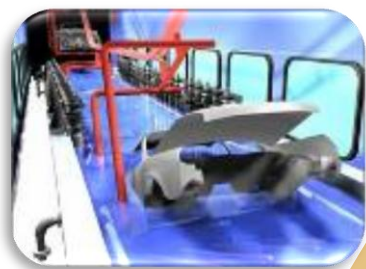
- Develop an environmentally friendly pretreatment system for multi-material DoD applications
 - Free of hexavalent chromium (Cr^{6+})
 - No volatile hazardous air pollutants (HAPs)
 - Ease of application using existing infrastructure
 - Equal or better corrosion performance to current (Cr^{6+}) wash primers
 - Broad substrate/topcoat compatibility
 - Cost effective

Zirconium-Based Pretreatments

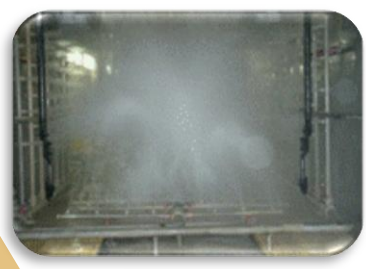
- Commercial Zirconium-Based Pretreatment
 - No regulated metals in pretreatment
 - Reduced energy cost for pretreatment application
 - Reduced water consumption for pretreatment application
 - Reduced pretreatment waste
 - No HAPS or VOC in pretreatment system
- Do commercial zirconium-based immersion pretreatments meet DoD specifications?
 - Confirm/determine that existing formulas meet DoD standards
 - Modify to meet DoD needs as necessary
 - Early experiments suggest Automotive OEM formula may not be directly applicable to DoD substrates/coating systems

Environmentally Friendly Zirconium Oxide Pretreatment

Task 1: OEM Pretreatment Development



immersion-applied ZrOx



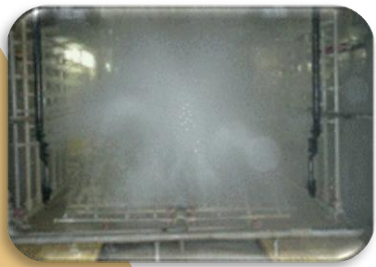
spray-applied ZrOx

Task 3: Repair Pretreatment Development



- Sanding
- Spray-Gun applied
- Wand applied
- Wipe-on

Task 2: Depot Pretreatment Development



Environmentally Friendly Zirconium Oxide Pretreatment

Task 1: OEM Pretreatment Development



immersion-applied ZrOx



spray-applied ZrOx

- Evaluate commercial immersion formulae with DoD substrates and coatings - reformulate as needed (Mil-Spec testing at ARL).
- Investigate and optimize lab prototype formula with a range of spray application conditions (Mil-Spec testing at ARL).

Environmentally Friendly Zirconium Oxide Pretreatment

- Visit DoD depot facilities to benchmark application process/conditions
- Determine compatibility of OEM spray formula with depot equipment.
- Characterization and limited Mil-Spec testing
- Formula optimization
- Comprehensive Mil-Spec testing

Task 2: Depot Pretreatment Development



Environmentally Friendly Zirconium Oxide Pretreatment

- Surface characterization.
- Evaluate optimized ZrOx spray formulation
- Limited Mil-Spec testing
- Reformulate
- Characterize
- Comprehensive Mil-Spec testing

Task 3: Repair Pretreatment Development



- Sanding
- Spray-Gun applied
- Wand applied
- Wipe-on

Acknowledgements



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Zirconium-Based Pretreatment

